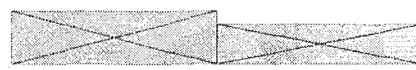
Figure 12B

HP TURBINE RETROFIT
DERIVATION OF HP SECTION EFFICIENCY AND SHAFT POWER
(FINAL FEEDWATER EXTRACTION FROM AFTER HP STAGE 4)



2202 lb/h to SSR
(M2)
2619 lb/h to Hot Reheat
(M3)

636.8 psia
634.0 °F
1308.5 Btu/lb
(H6)

17115 lb/h
(M4)
1461.1 Btu/lb
(H4)
To IP Rotor Cooling

636.8 psia
1308.3 Btu/lb

HP TURBINE
(M1)

6,900,000 lb/h
2400 psig
1000 °F
1461.1 Btu/lb (H1)

HP TURBINE
SHAFT POWER

2342.3 psia
1461.1 Btu/lb

The above data are provided for information only.

713372 lb/h (M5)
1222.7 psia
804.2 °F
1380.4 Btu/lb (H5)
Volumetric flow 111.0 ft³/sec
To Final Feedwater Heater
(Final feedwater temperature 568.4°F)

Unit Output = 965897 kw
Unit heat rate = 7565 Btu/kWh

HP TURBINE SHAFT POWER
(1% Feedwater make-up assumed)

$$= \frac{(M1-M2-M3) \times (H1-H6) - M4 \times (H4-H6) - M5 \times (H5-H6)}{3412.14 \times 1000}$$

$$= 292.5 \text{ MW}$$

HP TURBINE EFFICIENCY
including Valves
(1997 Steam Tables)

$$= \frac{H1 - H6}{H1 - H6'} \times 100 = 92.4 \%$$

Figure 12A

HP TURBINE RETROFIT
DERIVATION OF HP SECTION EFFICIENCY AND SHAFT POWER
(FINAL FEEDWATER EXTRACTION FROM AFTER HP STAGE 5)

2256 lb/h to SSR
(M2)
2561 lb/h to Hot Reheat
(M3)

651.1 psia
639.4 °F
1310.8 Btu/lb
(H6)

17115 lb/h
(M4)
1461.1 Btu/lb
(H4)
To IP Rotor Cooling

651.1 psia
1310.6 Btu/lb

HP TURBINE
(M1)

6,900,000 lb/h
2400 psig
1000 °F
1461.1 Btu/lb (H1)

HP TURBINE
SHAFT POWER

2342.3 psia
1461.1 Btu/lb

568030 lb/h (M5)
1091.2 psia
772.4 °F
1367.0 Btu/lb (H5)
Volumetric flow 96.7 ft³/sec
To Final Feedwater Heater
(Final feedwater temperature 554.6°F)

These data are provided for information only.

Unit Output = 982467 kW
Unit heat rate = 7569 Btu/kWh

HP TURBINE SHAFT POWER
(1% Feedwater make-up assumed)

$$= \frac{(M1-M2-M3) \times (H1-H6) - M4 \times (H4-H6) - M5 \times (H5-H6)}{3412.14 \times 1000}$$

$$= 293.6 \text{ MW}$$

HP TURBINE EFFICIENCY
including Valves
(1997 Steam Tables)

$$= \frac{H1 - H6}{H1 - H6'} \times 100 = 92.4\ \%$$

IP70105 94

INTERMOUNTAIN POWER SERVICE CORPORATION
RESPONSE TO TELECON QUESTIONS OF 3 JANUARY 2001

Q.1 Please provide information indicating the effect on cycle parameters of moving the HP steam path extraction to the final feedwater heater one stage upstream (from after Stage 5 to after Stage 4).

Response

Please find attached two diagrams indicating the effect of moving the extraction from after HP Stage 5 (Figure 12A) to after HP Stage 4 (Figure 12B). Note that Figure 12A is based on Figure 12 from Section 5 of the ALSTOM Power proposal with additional data added.

The two diagrams allow comparison of extraction steam pressure, temperature, enthalpy, mass flow and volumetric flow together with comparisons of final feedwater temperatures, HP exhaust pressure and temperature, HP shaft power and unit output and heat rate for the two steam extractions.

It will be noted the steam mass flow extracted to the top heater at higher pressure increases by just over 25% whilst the specific volume reduces by only 9%. The net effect is to increase the volumetric flow rate to the top heater by approximately 15%. IPSC is advised to consult the original supplier of the HP feedwater heater to assess whether it can be operated safely with increased steam pressure and increased steam velocity.

It will also be noted that the overall reduction in unit output is only 16.5 MW (not the 23 MW stated in the phone call). This value is based on using the same heater TTDs in both cases and now takes into account the variation in bled steam pipe pressure drops with increased extraction steam flow.

ALSTOM Power confirms that the change in steam extraction position can be accommodated mechanically in the steam turbine design. If desired, it would also be possible to redesign the HP turbine retrofit offered to provide an intermediate steam extraction pressure (e.g. to minimize the increase in extraction steam pressure/velocity).

The data provided on Figures 12A and 12B are for information only. ALSTOM Power would be prepared to formulate new performance guarantees corresponding to the revised extraction arrangement or to a different agreed arrangement.